Investigating How the Multiscale Heterogeneity of Hydrogeologic Properties Affects Flow and Transport at Yucca Mountain, Nevada

Paul Cook and Joe Wang
Contact: Paul Cook, 510/486-6110, pjcook@lbl.gov

RESEARCH OBJECTIVES

Much of the exposed rock within the underground tunnels at the proposed repository site for disposal of high-level radioactive nuclear waste at Yucca Mountain, Nevada, has been mapped for fractures and cavities. It is thought that such features (the fractures and cavities) would be the most likely pathways for possible hydrological flow. Yet surface feature mapping gives very little indication as to the capability of these features to transmit fluids. An ongoing effort to dynamically "map" potential hydrological features of this type, using pneumatic testing at the Yucca Mountain Exploratory Studies Facility (ESF), has been under way as part of the systematic testing program there. Systematic testing at regular intervals, the choice of which is unbiased by previous knowledge of specific features (such as large fractures or an extra abundance of fractures/cavities), is in progress. This type of testing is crucial for understanding the overall hydrological characteristics and associated heterogeneity of the proposed repository units.

APPROACH

Pre-existing 4 m boreholes, drilled at regular intervals every 5 to 10 m along a 500 m "rib" (wall) of the ESF Main Drift, facilitate a series of pneumatic tests utilizing a borehole packer. Using this packer with pneumatic flow control and pressure measurement equipment enables an air-permeability profile to be developed for each of these boreholes. The spatial resolution of these profiles can be adjusted from the length of the whole borehole down to 0.33 m, allowing different scales of features inside the holes to be measured for air permeability. A statistical understanding of the size of impermeable blocks within the holes and of the frequency and spacing of high-flow features is being developed.

ACCOMPLISHMENTS AND SIGNIFICANCE OF FINDINGS

Testing has progressed through 29 of the series of boreholes. Figure 1 shows the permeability profiles at the 0.33 m resolution in the 29 boreholes along a 230 m section of the drift. There is one borehole longer than the others that is thought to intersect the Sundance Fault of Yucca Mountain. A higher permeability at that location (caused by the fault) may account for the higher peak in the profile seen towards the end of that borehole. That some boreholes have extremely low permeability near the rib is somewhat counterintuitive, when considering that the atmospheric boundary at the rib might bias the measurement to a higher value. The presence of the drift itself, however, may cause existing features, particularly if near-horizontal, to close under load, lowering their permeability. As the systematic pneumatic testing progresses, a catalogue of flow characteristics for a growing length of drift is being developed in two dimensions, spanning a range of scales from the 0.33 m interval length, to borehole scale, to drift scale (obtained from borehole-to-borehole comparisons).

ACKNOWLEDGMENTS

This work was supported by the Director, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, through Memorandum Purchase Order EA9013MC5X between Bechtel SAIC Company, LLC, and the Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab). The support is provided to Berkeley Lab through the U.S. Department of Energy Contract No. E-AC03-76SF00098.

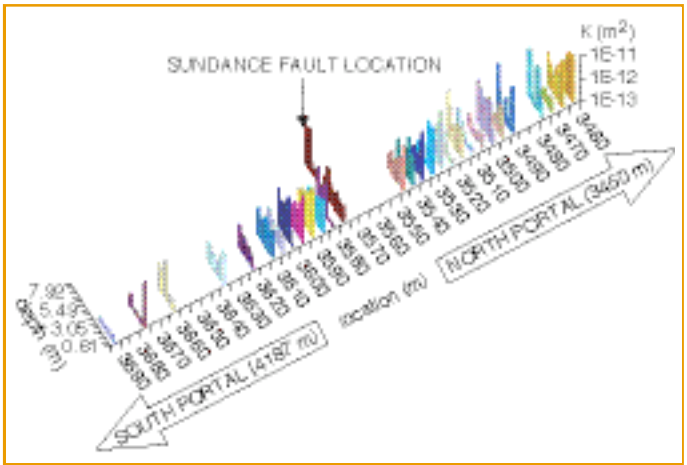

Figure 1. The section of the ESF Main Drift that has been pneumatically profiled